CALIFORNIA INSTITUTE OF TECHNOLOGY
HALE OBSERVATORIES
Pasadena, California

SEMI-ANNUAL STATUS REPORT

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Grant NGL 05-002-140

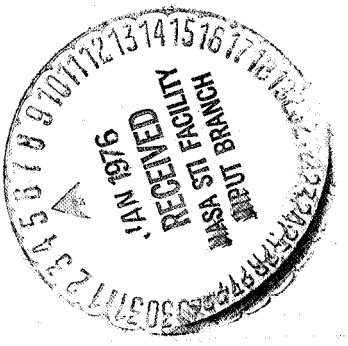
for the period

April 1, 1975, to October 31, 1975

Guido Münch

Principal Investigator

December 15, 1975



I. PERSONNEL WORKING UNDER THIS GRANT DURING REPORTING PERIOD

Dr. G. Münch, Principal Investigator, no salary charge to Grant

Dr. Keith Taylor, Post-Doctoral Research Fellow, 100% time

Mr. D. Rabin, Graduate Student, Summer 1975 only

Mrs. M. Katz, Computing Assistant, 3/8 time basis.

II. SUMMARY

Observational Programs

a) Interferometric spectroscopy of Titan, Saturn and the emission region around Io with the PEPSIOS spectrometer of the U. of Wisconsin at the 200-inch coude. Collaboration with F. Roesler and J. Trauger of the U. of Wisconsin. Transportation costs of the equipment from Wisconsin to Palomar has been paid with funds from this Grant.

b) Imaging interferometry of the Sodium emission region around Io, with the 60-inch Mt. Wilson telescope at its coudé focus. First an image intensifier was used for this work. Later an intensified Vidicon, belonging to JPL, was installed, in collaboration with Bergstrahl.

c) Interferometry of the $H_2(3,0)$ lines in the spectrum of Jupiter obtained over various regions of the disk (limb darkening)

III. INSTRUMENTATION

Design and construction of the imaging interferometer, by Keith Taylor and G. Münch. The construction of the 40mm aperture PEPSIOS for the Palomar coude has been continued. A data system (hard wired computer) which belongs to the Caltech Geology Department, has been reconditioned for the operation of the Palomar PEPSIOS. It will go into operation next february.

IV. OBSERVATIONAL PROGRAMS AND RESULTS

The emission region associated with Io

In July 1975 we had a highly succesful 3 night run with the 200-inch telescope, during which intensive work on the Io emission region was performed. The University of Wisconsin PEPSIOS was used for this purpose, in collaboration with F. Roesler and J. Trauger. Sixty high resolution profiles (resolution 0.062 A is 3 times higher than that used by Trafton or by Brown et al) were obtained with a variety of apertures at various distances from Io. A sample of the exquisite quality of this material is enclosed to demonstrate their vast superiority to anything that has been obtained before. It appears from these profiles that the whole Io emission phenomenon is very much more complicated than what previous workers have lead us to believe. The shape and height of the line profiles vary not only with phase, but also in an irregular fashion with time. We are proceeding with the analysis and modeling of these profiles.

The Potassium emission line at λ 7699 A was detected and measured also with very high accuracy (the resolution if 15 times higher than that used by Trafton). For reasons not yet understood, the KI line has a different shape than the D2 line, and it would appear thus that the path for the formation of the 2 lines is different. Nevertheless, if their intensities are interpreted as those of weak lines (unsaturated) an abundance ratio $[K]/[Na] = 1/40$ is obtained, close to the solar or meteoritic value.

Following the Palomar run on Io, it was realized that a a close monitoring of the emission was needed. Accordingly, an imaging interferometer was designed and built by Taylor and Münch, to be used at the coudé focus of the Mt. Wilson 60-inch telescope. Using

parts and components availaible, the instrument was put together in about 3 weeks. A brief description of the instrument is given in the enclosed description of one of the photographs. Because of the very short focal length of the imaging lens used (the f:1.4 lens of my personal property KONICA 35mm camera), we experienced troubles with water condensation in the refrigeration system used to cool the photocathode of the image intensifier used as detector. The main results of these photographs is that the Io sodium emission has maximum intensity within 20° of a plane which is not the orbital plane of Io. Rather it appears that is more closely associated with the Jupiter magnetic equator. This result had been suggested by Trafton (read in Preprint form), but because I did not believe his results, I undertook the experiment. In November, a more refined experiment was done with the same interferometer. In collaboration with Bergstrahl, we installed the JPL intensified Vidicon as detector, instead of the image intensifier. With the Vidicon we detected the Na fringes within 100 arc sec from Io in 40 minute exposure. It appears that this is the way to go, because with the data in digital form the subtraction of scattered light from Io and Jupiter can be effected. This is the limiting factor of the photographic exposures. The Vidicon approach obviously is the way to go. Unfortunately we had no more telescope time, until next January. But for the next Jupiter apparition I have reserved 30 nights at the Mt. Wilson 60-inch to follow closely the motions, shape and intensity of the Na-emission. The Vidicon of Jim Westphal will be used and the work will be followed by a Graduate Student as a Thesis project under my supervision.

Jupiter

In past years I have obtained profiles of the $H_2(3,0)$ lines over

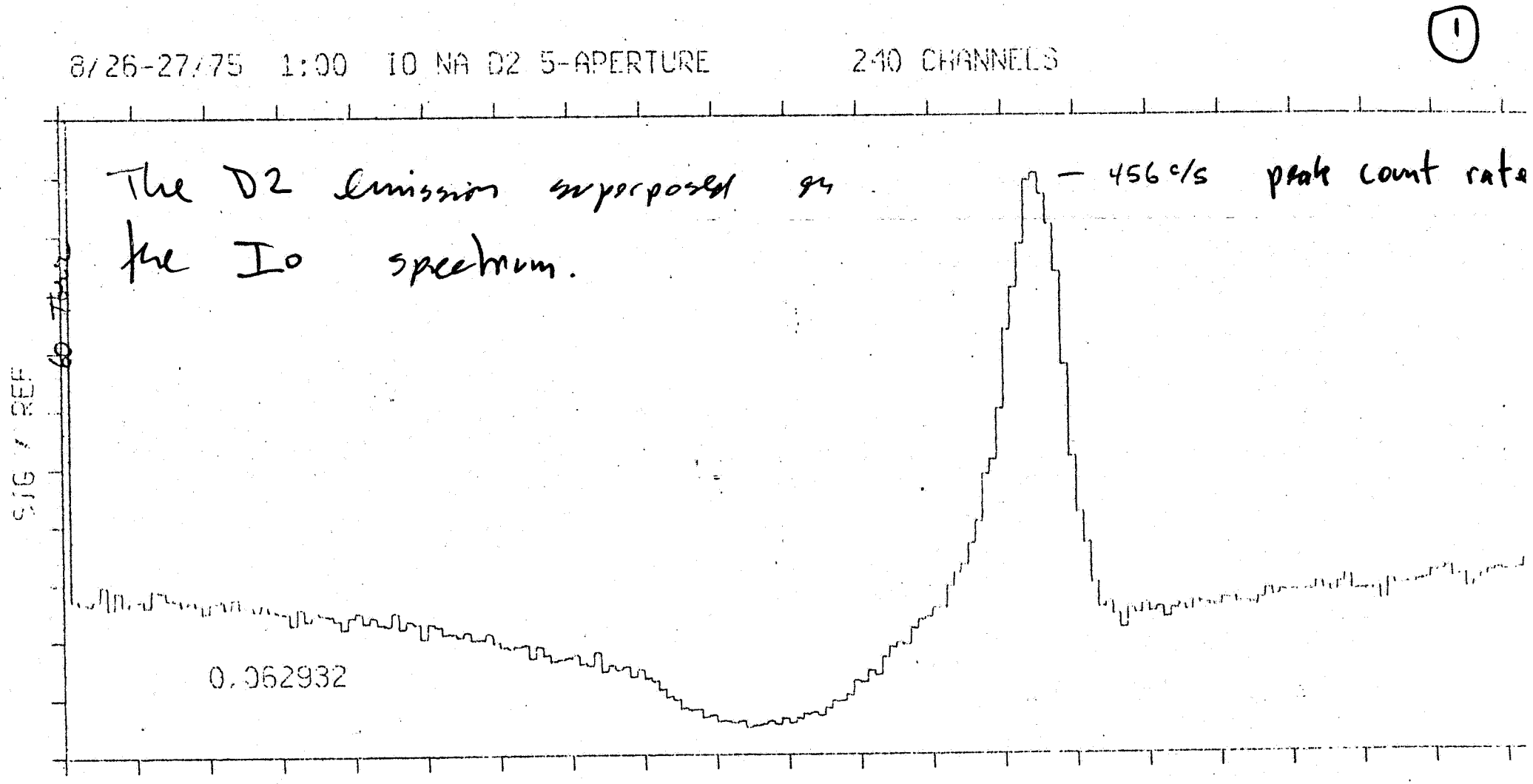
various regions of the Jupiter disk, with the hybrid Fabry-Perot interferometer of the Mt. Wilson 100-inch coudé . After seeing a preprint of a paper by Wm. Hayden Smith, which contained profiles of the H_2 lines with a quality much inferior to those I have, I decided to bring the project to completion. Just about then, Carl Pilcher, of the University of Hawaii wrote to the Director of the Hale Observatories requesting time to to this kind of work with the 100-inch coude scanner. After I showed him my profiles he realized that my approach is superior and we decided to collaborate. We had in november 8 nights of observations, under excellent seeing conditions. Pilcher has the data now for its reduction. Next Spring we plan to do also Saturn.

V. Financial status

On Nov. 30, 1975, the Grant funds spent were 69%. The main expenditures for the year have been in the construction of components for the Palomar PEPSIOS. The only parts to be yet fabricated is the hardware involved in the mounting and the construction of the pressure control manifolds (plumbing). With only the salary on 3/8 time basis of one assistant it appears that we can finish the project with funds availaible.

VI. Planned observing runs

Titan photometry in the IR 2 out of 5 nights in January 1976. 200-inch Search for the HD features in Saturn. $H_2(5,0)$ lines in Uranus. 8 nights in february, together with Roesler and Trauger with their PEPSIOS at the 200-inch.

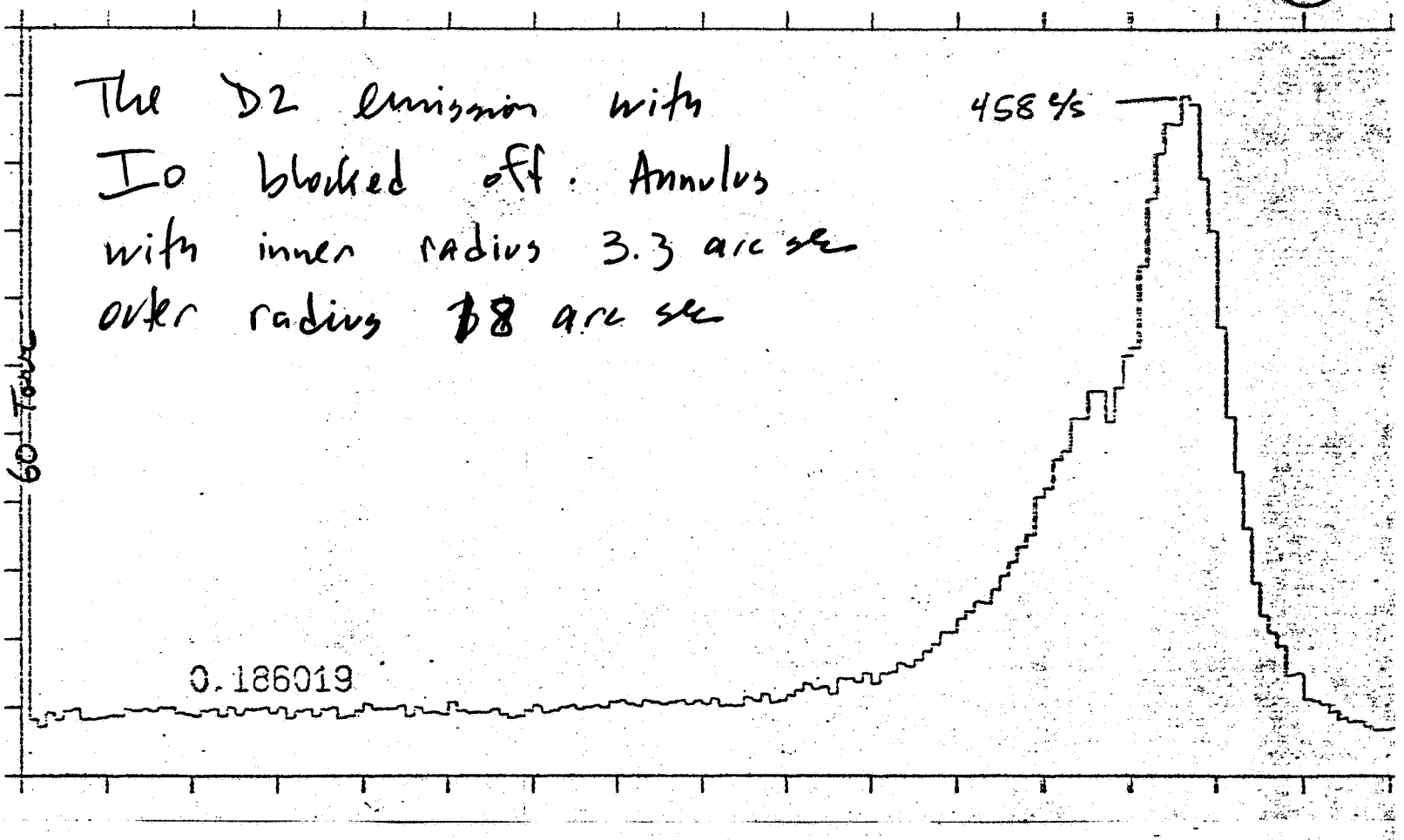


(1)

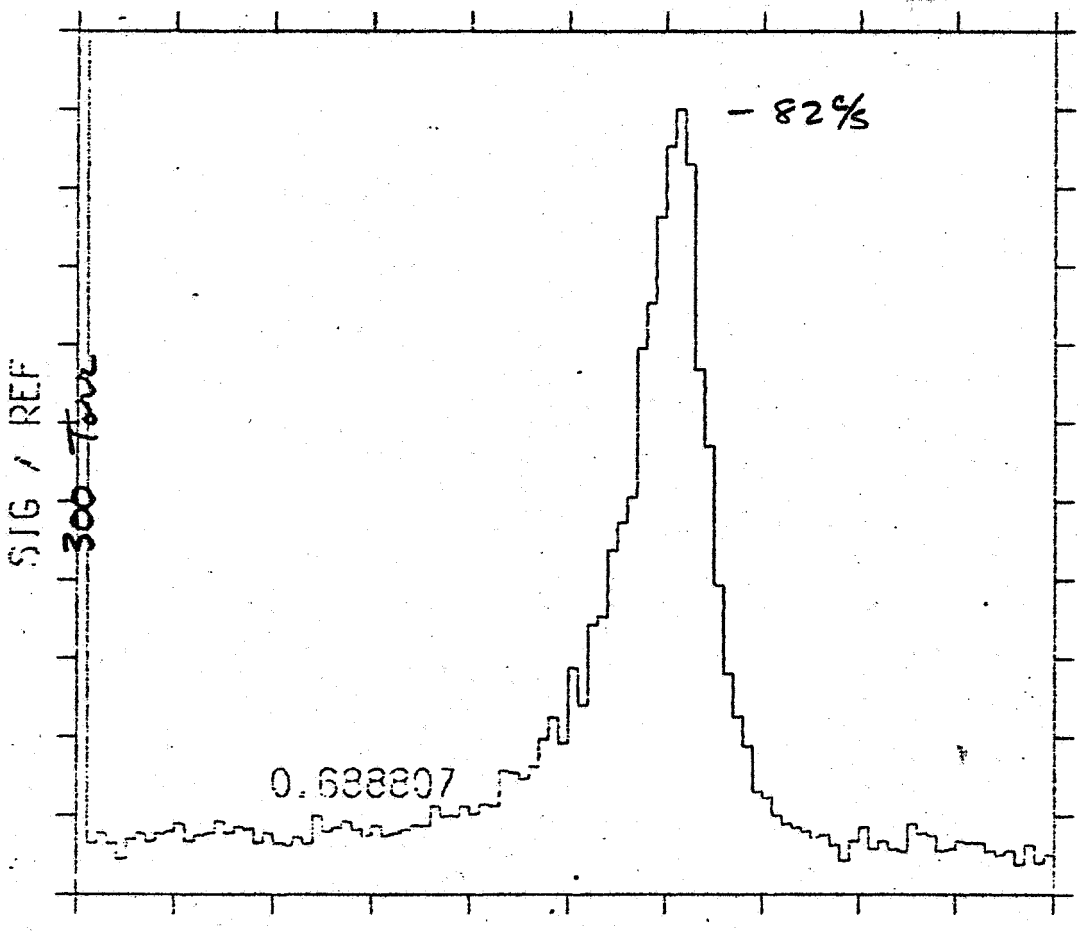
The D2 emission superposed on the Io spectrum.

— 456 c/s peak count rate

8/26-27/75 12:35 IO NA D2 5-28-ANNULUS 190 CHANNELS (2)

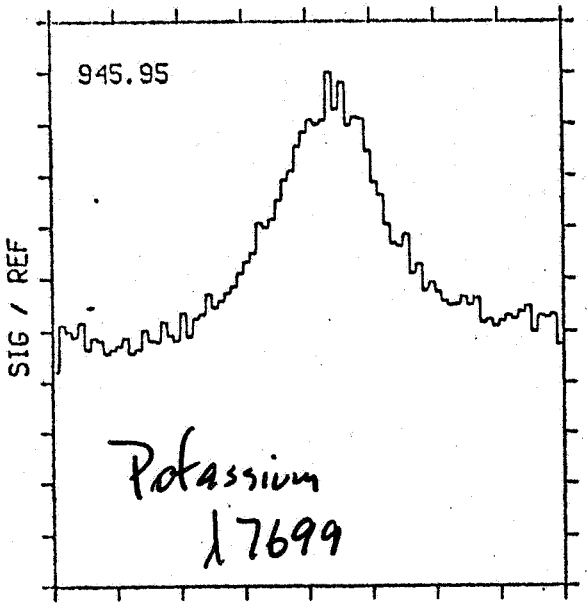


8/26-27/75 4:00 IO NA D2 5-APERTURE-IN 100 CHANNELS (3)



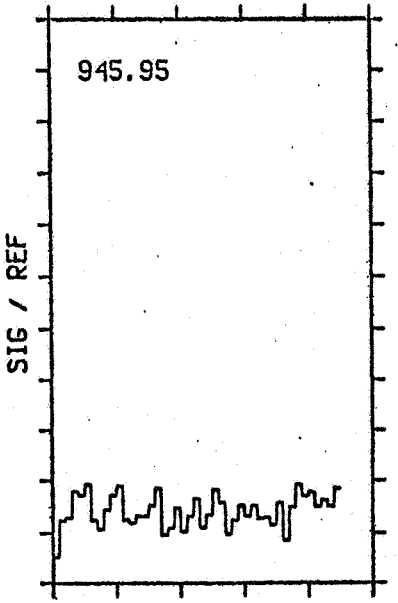
6.6 arc sec circular aperture just off Io towards Jupiter

8/28-29/75 IO KI 4-28-ANNULUS 80 CHANNELS

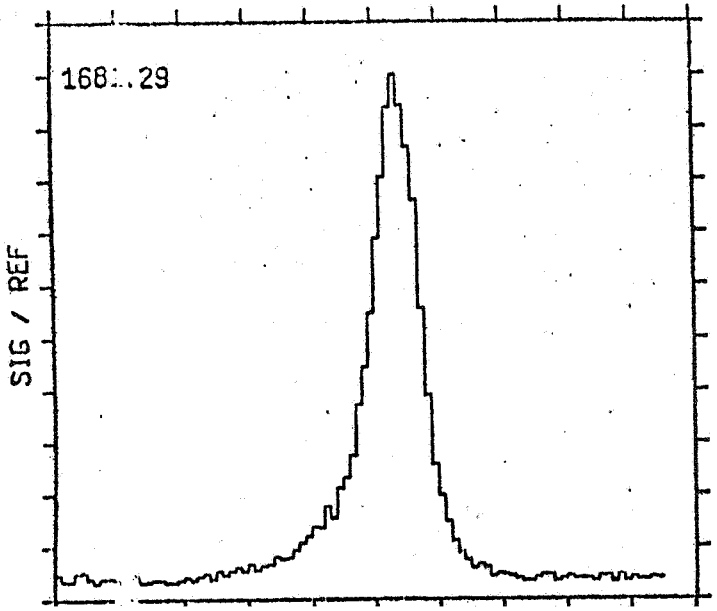


Potassium
λ7699

8/28-29/75 KI SKY BACKGROUND 45 CHANNELS

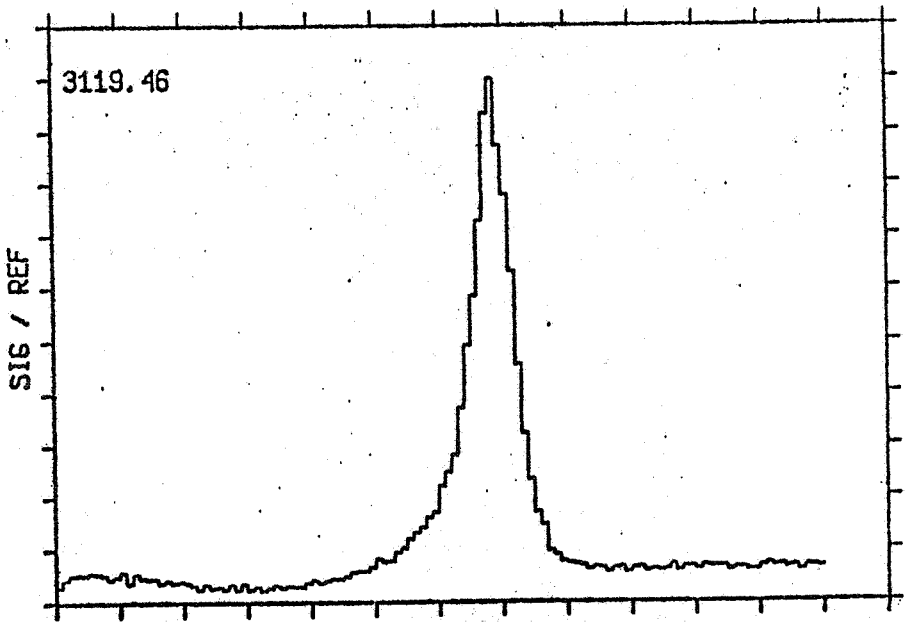


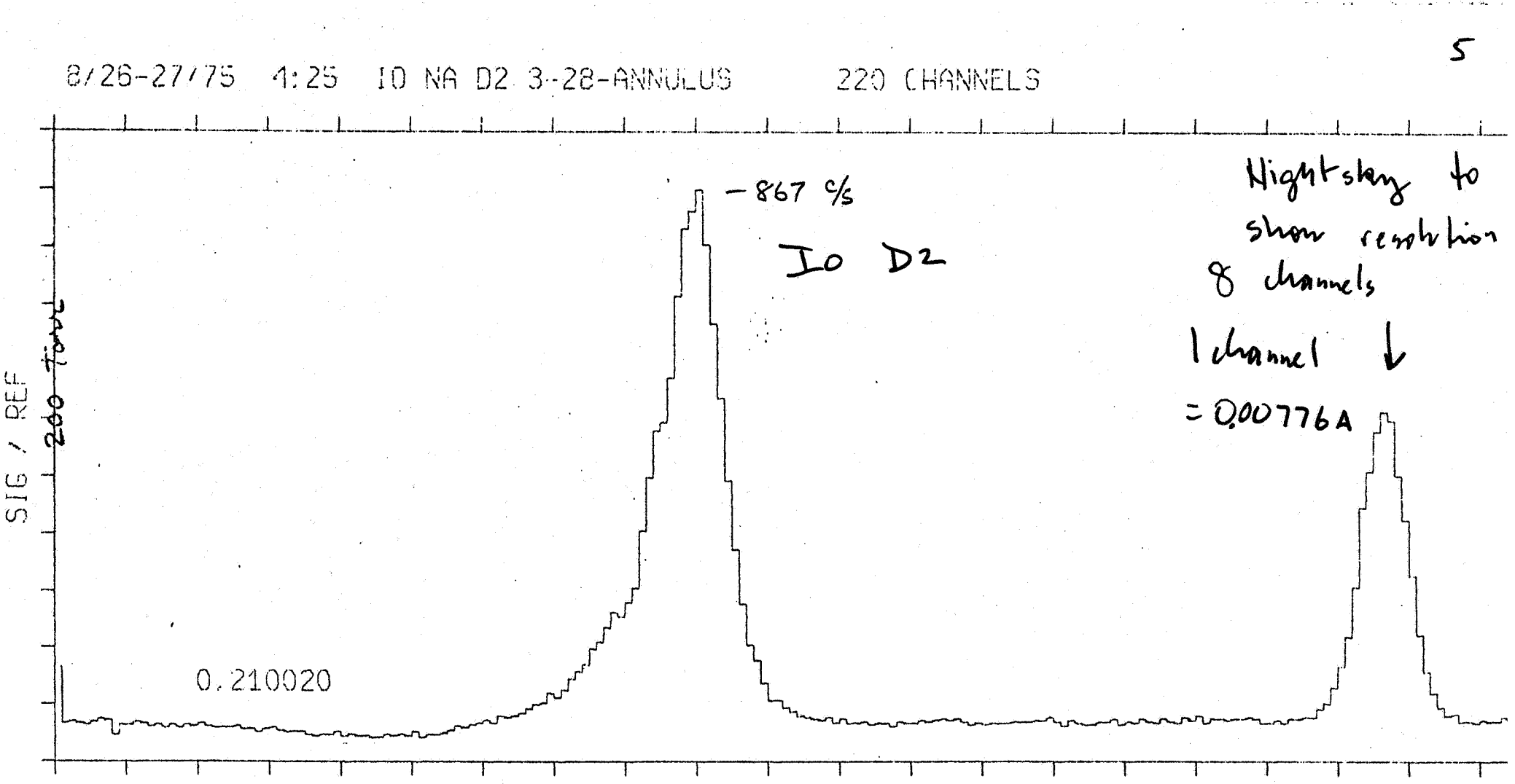
8/28-29/75 2:18 IO NA D2 4-10-ANNULUS 100 CHANNELS



Notice how symmetric are these two profiles, as compared with those of ② & ③

8/28-29/75 2:37 IO NA D2 2-10-ANNULUS 128 CHANNELS




8/26-27/75 1:25 IO NA D2 3-28-ANNULUS 220 CHANNELS
SIG / REF
200 Toul
0.210020
~867 c/s
Io D2
Night sky to show resolution
8 channels
1 channel
= 0.00776 A

INTERFEROMETRIC IMAGE OF THE SODIUM CLOUD AROUND IO

Obtained Oct. 6, 1975, 1:55 UT, with the 60-inch Mt. Wilson telescope by Guido Münch.

Photograph taken with an image intensifier ITT F4089 and an exposure of 2^h05^m, through a 57 mm f:1.4 lens. The rings of a Fabry-Perot etalon with a 2.3409 mm spacer have been centered at Io and projected in the plane of the sky by a 400 mm collimator. The rings corresponding to the D1 and D2 lines are concident. The dark line is the fiducial N-S direction, with North at top and East to right. The light of Io has been used for guiding by reflection from a central occulting disk 6 arc sec in diameter. The strongest Sodium emission can be seen in the two rings towards Jupiter and the NE from Io, which have radii of 22 and 34 arc sec. The mean position angle of maximum emission is 56°, which agrees with the position of the magnetic equator for the date. The corresponding position angle for the rotational equator is 66°, definitely off the symmetry direction of the Na-emission.